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Archives of Dental Research

Journal homepage: https://www.adr.org.in/

Original Research Article

Radiographic study of the appearance, location and size of mental foramen on digital panoramic radiographs

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ARTICLE INFO

Article history:
Received 14-01-2023
Accepted 21-01-2023
Available online 20-02-2023

Keywords:
Mental foramen
OPG
Implant
Punjabi

ABSTRACT

Introduction: Aim of the present study is see the position of mental foramen on OPG in the local Punjabi population.
Materials and Methods: This study was carried out on 305 digital panoramic radiographs of North Indian (Punjabi) population. Patients aged from 18 to 64 years were divided into 2 groups. Group A consisted of those patients between 18 and 40 years and Group B were between 41 and 64 years of age.
Results: On the right side, the most common shape of the metal foramina in Males and Females are *Round* (51.4%) and *Oval* (39.2%) respectively. The most common horizontal location of MF on the right side was found to be *Location "d" (that is in line with the root of* 2^{nd} *Premolar)* accounting to be 54.3% and 45.5% in males and females respectively. The vertical location is variable on the right and left side and the location is *more towards the lower border of mandible than the alveolar ridge.* In males, size was bit larger on left than right side and in females; it was almost same on both the sides.

1. Introduction

The Mental Foramen (MF) is situated halfway between the inferior and alveolar edges of the body of the jaw.[1–4] It is situated in a vertical line with the supraorbital notch, in between the premolars. It offers a route for the vessels and mental nerve to leave.[3,5] Dental surgeons performing surgical procedures on the mandible, such as curettage of premolars, filling procedures, dental implants, root canal treatments, orthognatic surgeries, etc. would benefit greatly from precise understanding of changes in the location, shape, and size of the MF. Additionally, it is crucial to have an effective and successful anaesthesia before surgery during nerve blocks and patient's perception to pressure and discomfort was lowest to mental nerve block.[4,6,7] Both diagnostic and clinical methods depend on the precise localization of the MF. The soft tissues of the chin, lower lip, gingiva, and anterior mandibular mucosa are innervated by the mental nerve as it leaves the MF and typically has three to four branches. When performing incisions and osteotomies close to the MF, the practitioner is urged to keep a safe distance. During periapical surgery, orthognathic surgery, or mandibular fixation or reduction, the mental bundle may be injured and experience paresthesia or anaesthesia. Furthermore, if the MF is close by, local anaesthesia of the terminal incisive branches of the inferior alveolar nerve and mental nerve can be obtained. Additionally, the likelihood of surgical treatments close to the MF has increased as a result of recent advancements in mandibular implant technique and rising orthognathic

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https://doi.org/10.18231/j.adr.2022.020

surgery frequency.[8] At the level of the lower premolar apices, the mental foramen is seen radiographically as a rounded or ovalradiolucent region.[9–11] In the past thirty years, panoramic radiographs have become more and more popular. This method has several benefits over intraoral radiography, including extensive coverage of both soft and hard tissues, continuity of the visualised area, and speed at which the view is formed. It is possible to locate MF more precisely in both horizontal and vertical directions when the complete mandible can be seen. However, due to magnification, it appears a little bit bigger on panoramic radiographs than on periapical radiographs. However, the manufacturer's recommended magnification factor can be used to adjust the measurement value to 100%.[8,12]

Also, recent development of mandibular implant techniques and increasing frequency of orthognathic surgery has increased the possibility of surgical procedures near the MF. It is also ideal to the practice of acupuncture as the Jiachenjiang point lies within the mental foramen.[13] The aim of this study was to determine the appearance, horizontal and vertical location; and size of the mental foramen on digital panoramic radiographs in North Indian (Punjabi) population.

2. Material and Methods

This retrospective study was carried out on 305 digital panoramic radiographs of North Indian (Punjabi) population, out of which 79 fulfilled the inclusion criteria. Patients aged from 18 to 64 years were divided into 2 groups. Group A consisted of those patients between 18 and 40 years and Group B were between 41 and 64 years of age. Ethical clearance was taken for this study. All the radiographs were shot by digital panoramic machine, Model: Alldent HF Digital: Smart PAN^{DR}: System Software: Synergy Dental (Version: BV2.0.0.3) with exposure conditions 10mA and 85kV Max. The images were taken from July 2017 to December 2021. All the measurements were done by single examiner and repeated at day 7.

Out of 305 panoramic radiographs, 79 were selected who fulfilled the following inclusion criteria:[8,14]

1. High quality in terms of angulation and contrast
2. Age and gender are known
3. The mandibular canal and mental foramen region of the films must be free of any radiolucent or radiopaque lesions.
4. The mandibular posterior teeth from first premolar to the second molar are present.
5. Fully erupted permanent teeth.
6. It was easy to see mental foramen on either side of the mandible.
7. The first and second premolars were positioned and aligned very normally.

2.1. The exclusion criteria[8,14] were as follow

1. Patients under the age of 18.
2. The lower arch has extreme crowding and spacing
3. Missing upper premolars due to the likelihood of lower premolars/over eruption.
4. The presence of a radiolucent lesion anywhere in the lower jaw between the right and left first molars.
5. The existence of periodontal disease.
6. People undergoing or having completed orthodontic treatment.
7. Line of fracture involving the parasymphysis region.
8. Mixed dentition or insufficient tooth eruption.
9. Positioning mistakes and structure superimposition.

2.2. Appearance

The appearance of mental foramina on the panoramic radiograph was classified as any of the following types: Circular, Elliptical, Elongated, Irregular and others

2.3. Horizontal position

The horizontal position in reference to the tooth apices was identified and classified[8,15–17] in the manner shown below.

1. Prior to the first premolar.
2. In line with first premolar.
3. Between the first and second premolars.
4. In line with second premolar.
5. Between the first molar and the second premolar.
6. In line with first molar.

To determine the horizontal placement, the premolars' and the first molar's long axes were used as vertical references. At the occlusal level, a horizontal line XY was drawn. At the top of the second premolar, a line EF was drawn in parallel with the line XY. Lines XY and EF were parallel to lines AB, which was drawn as a perpendicular line crossing through the apex of the mandibular second premolar, the long axis of the clinical crown, and the inferior boundary of the mandible. The average position of the MF (relative to the line AB) with respect to the second premolar's apex was noted as being mesial, distal, or intersecting this line.[8]

2.4. Vertical position

Definition of the values of "x," "y," and "z" are given below.[8,18,19]

1. X: From the alveolar ridge to the upper border of mental foramen
2. Y: The diameter of mental foramen itself
3. Z: From the lower border of foramen to the lower border of mandible

The ratio of x: z will give the relative vertical field of mental foramen.

2.5. Size

For size, the greatest vertical and horizontal dimension of the mental foramina on right and left side was recorded.

The data were analysed by SPSS software version 20.

3. Results

Total of 305 panoramic radiographs were evaluated out of which 79 fulfilled the inclusion criteria. The age of the subjects ranged from 18 years to 64 years. Gender distribution shows female predominance with females being 55.69% (n=44) and males being 44.30% (n=35) [Table 1]. In this study we calculated intraobserver reliability (using Cronbach alpha) and all parameters were greater than 0.7 which was acceptable.

3.1. Appearance of mental foramina

On the right side, the most common shape of the metal foramina in Males and Females are *Round* (51.4%) and *Oval* (39.2%) respectively. However, on the left side, *Oval* shape (42.9) is the most common shape in the males and *Round* (32.1%) is the most common shape in the females.

On the right side, in both age groups (Group A and Group B) majority of MF appeared to be *Oval* type in 40.9% and 30.8% cases respectively. On the left side, *Round* type (37.9%_ was the most common in the age Group A and *Oval* (46.2%) is the most common in the age Group B. [Table 2]

3.2. Horizontal location of mental foramen (In relation to the apices of the teeth on the panoramic radiograph)

The most common horizontal location of MF on the right side was found to be *Location "d"* accounting to be 54.3% and 45.5% in males and females respectively, and on the left side also, *Location "d"* was the most common in males (51.4%) and females (45.5%).

Location "d" was again commonest among both the age groups on both the sides of the mandible, with 47 % cases in Group A and 61.5% cases in Group B on right side; and 45.5% cases in Group A and 61.5% cases in group B on Left side (Table 3).

3.3. Vertical location of mental foramina

Vertical location of mental foramina is given in Tables 4, 5 and 6.

The mean distance between the alveolar ridge to the upper border of mental foramen in males is 9.391mm (SD= 2.022) on right side and 9.470mm (SD=1.786) on left side, whereas in females it is 8.613 mm(SD= 1.690) on right side and 8.391mm (SD=1.924) on the left side.

The mean diameter of the mental foramen in males on the right side is 1.566mm (SD= 0.738) and on the left side is 2.109mm (SD= 1.472) and in females is 1.651mm(SD=0.779) on the right side and 1.632mm (SD=0.779) on the left side.

The mean distance from the lower border of the mental foramen to the lower border of the mandible in males is 7.808 mm (SD=1.898) on the right side and 7.617mm(SD=1.632) on the left side and in female it is 6.374 mm(SD= 1.909)on the right side and 6.726mm(SD=2.048) on the left side.

Value of "Z" showed statistically significant result between males and female on the right side.

3.4. Size of the mental foramen

Size of the mental foramen are given in Table 7.

The mean horizontal dimension and mean vertical dimension in males on right side was 1.515(SD=0.663) and 1.571(SD=0.735) respectively and in females on right side was 1.704(SD=0.857) and 3.328(SD=10.930) respectively. On left side, in males, the mean horizontal dimension and mean vertical dimension of mental foramina was 1.836(SD=0.775) and 1.809(SD=0.714) respectively and in females was 1.797(SD=1.380) and 1.64(SD=0.795) respectively. Horizontal dimension of the MF on the right side is the only statistically significant parameter in the different age groups.

4. Discussion

This study is conducted to know the position of mental foramen through which mental nerve exits. The mental nerve is liable to be traumatised during periapical surgery, orthognathic surgery, mandibular fixation/reduction, implant procedures resulting inparesthesia or anesthesia. In this study we used the panoramic imaging. The Panoramic radiography (PR) shows greater part of maxilla-facial skeleton as a continuous image, thus allowing for a more accurate localization of mental foraminas in both vertical and horizontal dimensions.[13,20]

The most common horizontal position of the foramina in our study is position "d" that is in line with 2^{nd} premolar on both sides in both the age groups which is in concordance with Naveen Srinivas et al.[21] W E Shankland 2nd[22], N M al Jasser.[23] J Jayaindhraeswara[13] found "c" that is between 1^{st} and 2^{nd} premolars most commonly. In another study by Naveen Srinivas et al.[24] between two south Indian population, he found no difference in the position of the mental foramen.

In our studies we tried to identify the vertical location of the mental foramen, and we found the vertical location is variable on the right and left side. We found that the location is more towards the lower border of mandible than the alveolar ridge. Our study is in concordance with Vaibhav gupta et al.[25]

The mean size of mental foramen in males was (1.5x 1.5 mm) on the right side and (1.8x1.8mm) on the left

Table 1: Gender distribution

		Gender						Chi-Square	P-Value
		Male		Female		Total			
	18-40	28	80.0%	38	86.4%	66	83.5%	.574	.449
Age	41-64	7	20.0%	6	13.6%	13	16.5%		
	Total	35	100.0%	44	100.0%	79	100.0%		

Table 2: Appearance of mental foramina bilaterally on panoramic radiograph (Age wise).

		Age						Chi-Square	p-value
		18-40 (Group A)		41-64 (Group B)		Total			
Appearance of mental foramen on right side	Ablong	5	7.6%	0	0.0%	5	6.3%	9.089	0.695
	Circular	1	1.5%	0	0.0%	1	1.3%		
	Elliptical	2	3.0%	0	0.0%	2	2.5%		
	Elongated	1	1.5%	0	0.0%	1	1.3%		
	Irrregular	4	6.1%	3	23.1%	7	8.9%		
	Oblong	2	3.0%	0	0.0%	2	2.5%		
	Oval	27	40.9%	4	30.8%	31	39.2%		
	Ovoid	1	1.5%	1	7.7%	2	2.5%		
	Round	18	27.3%	5	38.5%	23	29.1%		
	Spindle	2	3.0%	0	0.0%	2	2.5%		
	Square	1	1.5%	0	0.0%	1	1.3%		
	Triangle	1	1.5%	0	0.0%	1	1.3%		
	Triangular	1	1.5%	0	0.0%	1	1.3%		
	Total	66	100.0%	13	100.0%	79	100.0%		
Appearance of mental foramen on left side	Ablong	4	6.1%	0	0.0%	4	5.1%	7.950	0.539
	Circular	1	1.5%	1	7.7%	2	2.5%		
	Elliptical	1	1.5%	1	7.7%	2	2.5%		
	Elongated	1	1.5%	0	0.0%	1	1.3%		
	Irregular	7	10.6%	1	7.7%	8	10.1%		
	Oblong	1	1.5%	1	7.7%	2	2.5%		
	Oval	22	33.3%	6	46.2%	28	35.4%		
	Ovoid	3	4.5%	0	0.0%	3	3.8%		
	Round	25	37.9%	3	23.1%	28	35.4%		
	Spindle	1	1.5%	0	0.0%	1	1.3%		
	Total	66	100.0%	13	100.0%	79	100.0%		

Table 3: Frequency of Horizontal location of mental foramina on panoramic radiograph (gender wise).

		Gender						Chi-Square	p-value
		Male		Female		Total			
Horizontal Location of Mental Foramina on RIGHT side	Location ‘b’	1	2.9%	1	2.3%	2	2.5%	1.726	0.786
	Location ‘c’	8	22.9%	14	31.8%	22	27.8%		
	Location ‘d’	19	54.3%	20	45.5%	39	49.4%		
	Location ‘e’	7	20.0%	8	18.2%	15	19.0%		
	Location ‘f’	0	0.0%	1	2.3%	1	1.3%		
	Total	35	100.0%	44	100.0%	79	100.0%		
Horizontal Location of Mental Foramina on LEFT side	Location ‘a’	1	2.9%	1	2.3%	2	2.5%	1.718	0.887
	Location ‘b’	1	2.9%	3	6.8%	4	5.1%		
	Location ‘c’	11	31.4%	15	34.1%	26	32.9%		
	Location ‘d’	18	51.4%	20	45.5%	38	48.1%		
	Location ‘e’	4	11.4%	4	9.1%	8	10.1%		
	Location ‘f’	0	0.0%	1	2.3%	1	1.3%		
	Total	35	100.0%	44	100.0%	79	100.0%		

Table 4: Vertical position of mental foramen

Age		N	Mean	Std. Deviation	t-value	p-value
Vertical Right X/Z	18-40	66	1.394	0.521	.156	.876
	41-64	13	1.370	0.402		
Vertical Left X/Z	18-40	66	1.518	1.756	.380	.705
	41-64	13	1.332	0.150		

Table 5: Vertical location of mental foramen on right side (Gender wise)

Gender		N	Mean	Std. Deviation	t-value	p-value
X	Male	35	9.391	2.022	1.862	.066
	Female	44	8.613	1.690		
Y	Male	35	1.566	0.738	.494	.623
	Female	44	1.651	0.779		
Z	Male	35	7.808	1.898	3.326	.001**
	Female	44	6.374	1.909		

Table 6: Vertical location of mental foramen on left side (Gender wise).

	Gender	N	Mean	Std. Deviation	t-value	p-value
X	Male	35	9.470	1.786	2.555	.013*
	Female	44	8.391	1.924		
Y	Male	35	2.109	1.472	1.839	.070
	Female	44	1.632	0.799		
Z	Male	35	7.617	1.632	2.096	.039
	Female	44	6.726	2.048		

Table 7: Size of mental foramen (age wise)

Age		N	Mean	Std. Deviation	t-value	p-value
Horizontal dimension of mental foramen on RIGHT side	18-40	66	1.5194	.71315	2.691	.009**
	41-64	13	2.1308	.91777		
Vertical dimension of mental foramen on RIGHT side	18-40	66	2.6976	8.94618	.360	.720
	41-64	13	1.8000	.61237		
Horizontal dimension of mental foramen on LEFT side	18-40	66	1.7779	1.20300	.637	.526
	41-64	13	2.0000	.80104		
Vertical dimension of mental foramen on LEFT side	18-40	66	1.6953	.80536	.518	.606
	41-64	13	1.8154	.47407		

side. In the females size was (1.7x3.3mm) on the right side and (1.79x 1.64 mm) on the left side. In males size was bit larger on left than right side. In females, it was almost same on both the sides. The results were not statistically significant. Our study is in concordance with the study done by Vaibhav Gupta et al.[25] he found left size was larger than right whereas Philips et al.[26] found no difference on both the sides.

In our study the most common shape in males on right side is round and it is oval on the left side. Whereas in other study by ukoha et al.[27] he found round shaped foramen was more prevalent (75.76%) than the oval shaped foramen (25.24%) I Virendra Budhiraja et al.[28]found in (74.3%), cases the MF was oval in shape.

5. Conclusion

Based on the results of the present study it is concluded that, on the right side, the most common shape of the metal foramina in Males and Females are *Round* and *Oval* respectively. However, on the left side, *Oval* shape is the most common shape in the males and *Round* is the most common shape in the females. The most common horizontal location of mental foramina in relation to the apices of the teeth is *in line with the second premolar.* The vertical location is variable on the right and left side and the location is *more towards the lower border of mandible than the alveolar ridge.* In males, size was bit larger on left than right side and in females, it was almost same on both the sides. It is very important to have the accurate knowledge of the location, size and appearance of mental foramen before administering local anaesthesia or conducting any surgery of mandible near mental foramen.

These findings can be used as reference material by the dental practitioners of North India while performing clinical procedures involving mental foramen.

6. Source of Funding

None.

7. Conflict of Interest

None.

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Cite this article: Dua N, Sharma P, Kaur H, Kaur M, Girdhar M. Radiographic study of the appearance, location and size of mental foramen on digital panoramic radiographs. *Arch Dent Res* 2022;12(2):109-114.